933.P1/MXP/RPS/JB

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	Group Art Unit: 1763
BROWN, ET AL.	Examiner: Rudy Zervigon
Serial No.: 09/055,201	
Filed: April 3, 1998	
For: EXHAUST SYSTEM FOR TREATING PROCESS GAS EFFLUENT	March 23, 2000 San Francisco, California

APPEAL BRIEF

Box AF
Assistant Commissioner for Patents
Washington, D.C. 20231

Board of Patent Appeals and Interferences:

Attached is an Appeal Brief in response to the Examiner's Final Rejection and Appellant's Notice of Appeal.

The fees required under § 1.17(f), and any required petition for extension of time for filing this brief and fees therefor, are dealt with in the accompanying TRANSMITTAL OF APPEAL BRIEF.

This brief is transmitted in triplicate.

CERTIFICATE OF MAILING

I hereby certify that this correspondence and all documents listed herein are being deposited with the United States Postal Service as first class mail in an envelope address to: Box AF, Assistant Commissioner for Patents, Washington, D.C. 20231, on March 23, 2000, by Vanessa Shieh

Vanessa Shieh
Signature

(1) ***Real Party in Interest***

The real party in interest of the present application is Applied Materials, Inc., having a place of business at 3050 Bowers Avenue, Santa Clara, California 95054.

(2) ***Related Appeals and Interferences***

Appellant, Appellant's legal representative, and assignee are aware of no appeals or interferences which will directly affect or be directly affected by or have a bearing on the Board's decision in the present appeal.

(3) ***Status of Claims***

Claims 1-12, 14, 15, and 24-36 are presently pending in the case. Claims 1-12, 14, 15, and 24-36 are rejected by the Examiner. Claims 13 and 16-23 were previously canceled.

(4) ***Status of Amendments***

An amendment After Final was filed on October 22, 1999. In an Advisory Action mailed on November 10, 1999, the Examiner indicated that the

October 22, 1999 amendment would not be entered because the amendment was not deemed to place the application in better condition for appeal by materially reducing or simplifying the issues for appeal. In telephone interviews with the Examiner on December 16, 1999 and on February 16, 2000, Appellant explained to the Examiner that the amendments were made specifically for the purpose of reducing the issues for appeal. Appellant went on to explain that Appellant was not interested in filing an appeal before the issues were ripe. The Examiner reconsidered the holding in the Advisory Action and reconsidered the rejection of the amended claims. The Examiner determined that the claims were still rejectable under the present grounds and that an appeal at this time would be appropriate. The Examiner agreed to enter the amendment upon the filing of an Appeal Brief by Appellant. Thus, it is believed that the amendment of October 22, 1999 is due entry.

(5) ***Summary of the Invention***

The present invention relates to a gas treatment apparatus for reducing a hazardous gas content of an effluent from a process chamber. In the present invention, the gas treatment apparatus comprises an exhaust tube through which effluent from the process chamber may be flowed, the exhaust tube having an internal flow surface that is substantially absent projections or recesses that alter the effluent flow path. The gas treatment apparatus further comprises a microwave energy applicator to couple microwaves to the effluent flowing through the exhaust tube to reduce the hazardous gas content of the effluent.

An exemplary substrate processing apparatus, as illustrated in Figure 2 and described on page 7 line 15 through page 8 line 17, comprises a process chamber **25** having a support **30** adapted for holding a substrate **35**. A gas treatment apparatus is part of the exhaust system and comprises an exhaust tube **85** for exhausting effluent from the process chamber **25**. A gas energizer **90**, such as a microwave generator, energizes the effluent gas in the exhaust tube **85** to form an abatement plasma in which hazardous gas components in the effluent such as fluorocarbon, chlorofluorocarbons, hydrocarbon, and other fluorine containing gases, are dissociated or reacted with one another to substantially abate the hazardous gas content of the effluent. In an energized plasma gas, avalanche breakdown occurs in the gaseous stream when the individual charged species electrons and charged nuclei are accelerated in the prevalent electric and magnetic fields to collide with other gas molecules causing further dissociation and ionization of the effluent gas.

The exhaust tube **85** comprises an enclosed conduit through which a continuous stream of effluent flows as the effluent is energized by the gas energizer to abate the hazardous gas content of the effluent. The shape and size of the exhaust tube **85** are selected to provide unrestricted and continuous flow of effluent from the process chamber **25** while preventing back diffusion of the effluent into the process chamber. The exhaust tube **85** may be constructed to provide a laminar flow of effluent through the tube that undergoes little or no turbulence that would otherwise redirect the flow of effluent in directions other than along the longitudinal axial direction of the tube. In a preferred version, the exhaust tube comprises an internal flow surface that may be parallel to the direction of the flow of the effluent through the exhaust tube, and that is substantially absent or free of projections or recesses that alter the effluent flow path or provide a non-laminar flow of effluent. The smooth finish of the inner

surface of the exhaust tube **85** provides a more laminar and less turbulent flow of effluent along the flow path. The laminar flow eliminates turbulence of the effluent gas flow stream and reduces the possibility that effluent gas will diffuse back into the process chamber **25**. In addition, a laminar flow of effluent allows energizing radiation to be coupled in a high strength in the region immediately adjacent to the inner surface of the exhaust tube **85** to form a higher density of energized effluent gas or plasma. Also, because the effluent flows continually and uniformly past the inner surface of the exhaust tube **85**, the deposition of byproducts on the inner surface, which would otherwise accumulate and impede the coupling of the ionizing radiation, reduces the necessity to frequently clean the exhaust tube **85**.

The present gas treatment apparatus offers several advantages over prior gas treatment systems, such as the one shown in Figure 1 of the application. In the prior system, the abatement chamber configuration and associated magnetic field cause the energized effluent gas species to travel through the abatement chamber **12** in a circular pathway, to increase microwave power absorption into the effluent gas by "stirring" the energized effluent gas species in the confined abatement chamber. In addition, the abatement chamber **12** comprises an effluent inlet **22** that is offset from an outlet **24** to force the effluent gas to take a circuitous pathway from the inlet to the outlet to further increase microwave absorption. However, the circuitous pathway of the effluent gas reduces the rate at which the process gas effluent can be removed from the process chamber **14** and treated to remove hazardous gas content. This may result in back diffusion of the exhaust into a substrate processing chamber which can result in damaged or inconsistently processed substrates.

In one version, the exhaust tube **85** may be made from monocrystalline sapphire, which is single crystal alumina that exhibits high chemical

and erosion resistance in erosive gaseous environments, especially effluent gases that contain fluorine-containing compounds and species. The exhaust tube **85** of monocrystalline sapphire provides a unitary tubular structure having a chemically homogeneous composition that has several advantages over polycrystalline materials. The ceramic crystals in the monocrystalline sapphire exhaust tube **85** are oriented in substantially the same single crystallographic direction, and provide exposed surfaces having little or no impurity or glassy grain boundary regions that can erode rapidly in erosive fluorine-containing environments. The continuous and uniform crystallographic structure provided by the monocrystalline sapphire exhaust tube **85** exhibits reduced erosion or particulate generation. In addition, monocrystalline sapphire has a high melting temperature that allows use of the exhaust tube **85** at high temperatures exceeding 1000°C or even exceeding 2000°C. The monocrystalline sapphire exhaust tube **85** represents a significant advancement over conventional abatement chambers that are typically formed of aluminum which rapidly erodes in a plasma of fluorine-containing gases to reduce the chamber's operating life and increase maintenance costs.

In another version, the gas treatment apparatus comprises a gas analyzer **150** having a gas analysis probe **155** for detecting and monitoring the composition or concentration of hazardous gas components in the effluent stream, either before or after the effluent is energized. The gas analysis probe **155** may be mounted near the outlet of the exhaust tube **85** to measure the hazardous gas content of the energized effluent gas. The gas analyzer **150** is programmed to analyze the composition of the effluent gas, especially the hazardous gas concentration, and provide an output signal in relation to the hazardous gas content, to a computer controller system **160** that controls and adjusts the operation of the gas treatment apparatus and of process chamber **25** according to the output signal. In operation, the gas analyzer **150** continuously monitors the

hazardous gas content of the effluent emitted from the exhaust tube **85** and provides a continuous output signal, or a safety level output signal, that is triggered when the hazardous gas content of the effluent exceeds a safety level. The computer controller system **160** comprises a computer readable medium having computer readable program code embodied therein that monitors the output signal(s) from the gas analyzer and performs at least one of the following steps: (i) adjusts the operating power level of the gas energizer **90** to reduce the hazardous gas content of the effluent, (ii) adjusts process conditions in the process chamber **25** to reduce the hazardous gas content of the effluent, (iii) adds a reagent gas to the effluent gas to reduce the hazardous gas emissions, (iv) terminates a process conducted in the process chamber **25**, or (v) provides an alarm signal to notify an operator of dangerously high levels of hazardous gas in the effluent.

Thus, the present invention provides a gas treatment apparatus that can reduce a hazardous gas content of an effluent from a process chamber. The present invention also prevents the back diffusion of effluent gas into the process chamber, reduces erosion in the gas treatment apparatus, or operates in a safe manner.

(6) ***Issues***

There are presently six issues presented to the Board of Appeals for review:

(i) Whether claims 1, 2, 11, 31 and 33 are unpatentable under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent 5,137,701 to Mundt (hereinafter Mundt);

(ii) Whether claims 3-5, 8, 9, 11, 12, 14, 32 and 34 are unpatentable under 35 U.S.C. §103(a) as being unpatentable over Mundt in view of U.S. Patent No. 4,735,633 to Chiu (hereinafter Chiu);

(iii) Whether claim 6 is unpatentable under 35 U.S.C. §103(a) as being unpatentable over Mundt in view of Japanese Patent JP51-129868 to Itoga (hereinafter Itoga);

(iv) Whether claims 7 and 15 are unpatentable under 35 U.S.C. §103(a) as being unpatentable over Mundt in view of U.S. Patent 5,426,000 to Labib et al (hereinafter Labib et al);

(v) Whether claims 10, 24, 26-29 and 35 are unpatentable under 35 U.S.C. §103(a) as being unpatentable over Mundt; and

(vi) Whether claims 25 and 36 are unpatentable under 35 U.S.C. §103(a) as being unpatentable over Mundt as applied against claims 10, 24, 26-29, and 35 and further in view of Chiu.

(7) *Grouping of claims*

Claims 1-9, 31 and 32 stand and fall together. Claims 10-15, 26-30, 33, 34 and 36 stand and fall together. Claims 24, 25 and 35 stand and fall together. The separate patentability of each group will be discussed in the following section.

(8) Argument

Each of claims 1-12, 14, 15, and 24-36 are improperly rejected and are allowable for at least the reasons set forth below.

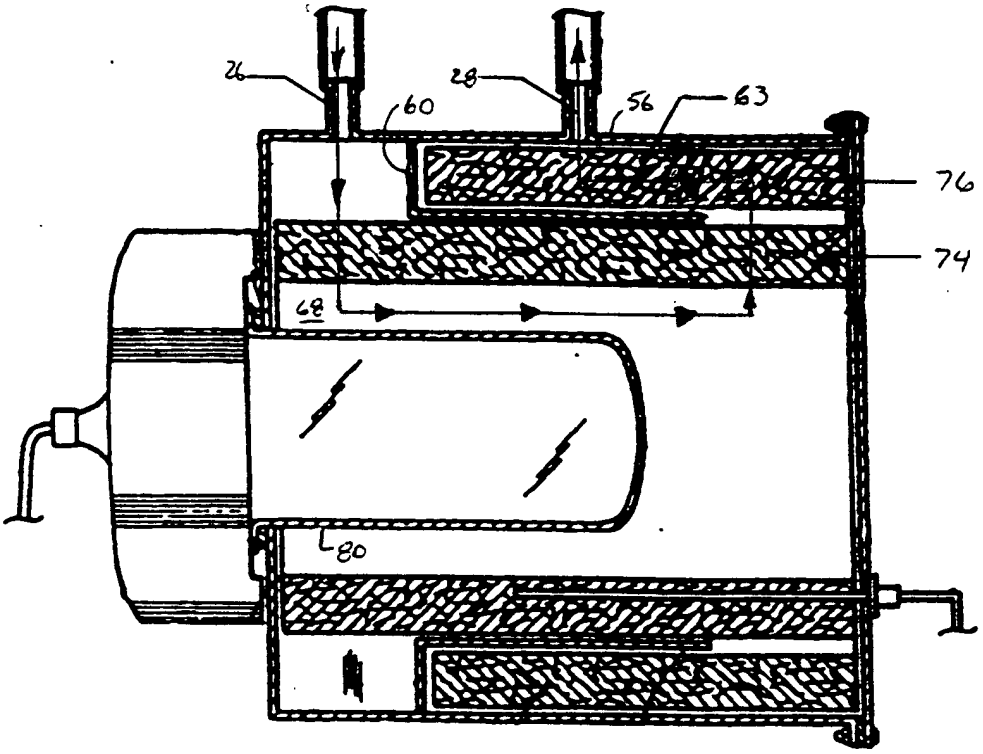
Appellant respectfully requests reversal of all grounds of rejection set forth by the Examiner.

(i) 35 USC 102(b) rejection of claims 1, 2, 11, 31, and 33

Appellant requests reversal of the Examiner's improper rejection of claims 1, 2, 11, 31 and 33 under 35 USC 102(b) as being anticipated by U.S. Patent 5,137,701 to Mundt (hereinafter Mundt). The Examiner erred in finding that the claims are anticipated by Mundt.

Mundt does not anticipate the claims because Mundt does not disclose each and every positively set forth element in the claims. For example, claim 1 is to a gas treatment apparatus for reducing a hazardous gas content of an effluent from a process chamber, the gas treatment apparatus comprising, inter alia, an exhaust tube having an internal flow surface that is substantially absent projections or recesses that alter the effluent flow path. In contrast, Mundt discloses a reactor (18) replete with projections and/or recesses **that are specifically designed to alter** the effluent flow path (see column 3 line 49 through column 4 line 11). For example, Mundt discloses a baffle member (60) and a tube (80) that serve as projections to redirect the flow of the effluent. Below is a diagram of the gas flow path through the reactor (18) of Mundt as superimposed in red (by Appellant) onto Mundt's Figure 3 (with reference numerals and lead lines of some elements removed for clarity). Mundt describes the altered gas flow in column 7, beginning

at line 9. As stated by Mundt: "baffle member 60 and tube 80 force gas to flow inwardly from inlet 26, longitudinally through an annular passageway 68 between tube 80 and baffle member 60 and back through an annular passageway 63 between the baffle member 60 and the sidewall 56 before exiting through the outlet 28." As shown by the red gas flow path above, Mundt clearly is **not** absent projections or recesses that alter the effluent flow path. As if the red gas flow path shown above were not enough to demonstrate that the gas flow path of Mundt is altered, the reaction chamber (18) of Mundt further comprises two tube-shaped masses of fibrous material. A first tube (74) defines a reactive element and has an outer diameter slightly less than the diameter of a baffle member (60). A second tube (76) defines a tubular condensation element and has an inner diameter slightly larger than the baffle member and an outer diameter slightly less than the inner diameter of the chamber. The fibrous meshes (74,76) have a cross-section that is 50 percent open and 50 percent closed to a gas flow (column 8, lines 8-11). Since the fibrous meshes are only 50 percent open, the other 50 percent is a



projection that alters the effluent flow path. Thus, the reactor and subsequent flow path disclosed by Mundt can not be considered to have an internal flow surface that is substantially absent projections or recesses that alter the effluent flow path.

Mundt, in this respect, is similar to the prior art discussed in the background section of Appellant's specification. On page 2 of the specification, Appellant discusses the disadvantages of reactors that have altered effluent flow paths. As stated on page 2, lines 24-28, "The circuitous pathway of the effluent gas reduces the rate at which the process gas effluent can be removed from the process chamber and treated to remove hazardous gas content. It is desirable to have a gas treatment apparatus having an effluent flow pathway that is not circuitously directed..." This disadvantage of altered flow paths is acknowledged by Mundt in column 7, lines 54-57: "In order to maintain unrestricted flow, it is desirable that the flow cross-section in reaction chamber 18 be approximately a factor of ten larger than the flow cross-sections of inlet 26 and outlet 28." In contrast, Appellant has invented a gas treatment apparatus, as claimed in claim 1, that does not alter the flow of the gas. The resulting advantageous apparatus, for example, does not have to made unduly large to prevent the backflow of effluent back into a process chamber. In addition, the lack of projections and recesses may also provide a laminar flow through the gas treatment apparatus. The laminar flow may allow energizing radiation to be coupled in a high strength in the region immediately adjacent to the inner surface of the exhaust tube to form a higher density of energized effluent gas or plasma and, because the effluent flows continually and uniformly past the inner surface of the exhaust tube, may reduce the deposition of byproducts on the inner surface, which would otherwise accumulate and impede the coupling of the ionizing radiation.

Mundt fails to disclose that which is claimed in claim 1 and therefore does not anticipate the claim. Claims 2 and 31 depend from claim 1 and distinguish over Mundt for the same reasons as their base claim.

Mundt also does not anticipate independent claim 11. Claim 11 is to a process chamber for processing a substrate and reducing emissions of hazardous gas to the environment comprising, inter alia, a gas analyzer capable of monitoring the hazardous gas content of the effluent in the exhaust tube and providing an output signal in relation to the hazardous gas content of the effluent and a computer controller system capable of monitoring the output signal from the gas analyzer and performing an action in response to the hazardous gas content of the effluent. Mundt fails to disclose that which is recited in claim 11. Mundt discloses a pressure monitor 36 and a controller that is responsive to the pressure signal and controls the operation of the apparatus in accordance with the detected pressure. Mundt's pressure detector is not a gas analyzer capable of monitoring the hazardous gas **content** of the effluent in the exhaust tube and providing an output signal in relation to the hazardous gas content of the effluent. Mundt fails to disclose the use of a gas analyzer. Nor does Mundt disclose a controller that is responsive to the output signal from the gas analyzer and that performs an action in response to the signal from the gas analyzer. Therefore, Mundt does not anticipate claim 11 or claim 33 depending therefrom.

It is respectfully requested that the rejection of claims 1, 2, 11, 31, and 33 as being anticipated by Mundt be reversed.

(ii) 35 USC 103(a) rejection of claims 3-5, 8, 9, 11, 12, 14, 32, and 34

Claims 3-5, 8, 9, 11, 12, 14, 32, and 34 were improperly rejected under 35 USC 103(a) as being unpatentable over Mundt in view of U.S. Patent 4,735,633 to Chiu (Chiu). Therefore, Appellant requests reversal of the rejections.

Mundt and Chiu do not render claims 3-5, 8, 9 and 32 unpatentable. Claims 3-5, 8, 9, and 32 depend from claim 1. As discussed above, claim 1 is to a gas treatment apparatus comprising, inter alia, an exhaust tube to reduce the hazardous gas content of the effluent and having an internal flow surface that is substantially absent projections or recesses that alter the effluent flow path. Mundt discloses an exhaust tube having projections, as discussed above. Chiu does not make up for the deficiencies of Mundt or teach the removal of the projections in Mundt's device. In fact, Chiu teaches the addition of even more projections and/or recesses. Chiu teaches a spiral electrode projection that alters and redirects the flow path of the gas even beyond the altered flow path of Mundt. For example, in column 5, lines 18-21, Chiu states, "To effect complete removal of the waste vapor molecules, ... it is necessary to increase the ratio of electrode area to reactor volume." To achieve this, in one embodiment, nested spiral electrodes 20, 22 are provided. "The gas flow will generally distribute around the **spiral flow paths** ... In addition to the spiral flow established by the spiral electrodes, there will be **cross-flow** established through gaps 32 ... such cross-flow helps establish uniform distribution of the effluent gas throughout the reaction chamber" (column 6, line 68 through column 7, line 9). In another embodiment, electrodes 60, 62 are stacked. "The flow path generally spreads **radially outward ... and then radially inward**" (column 7 lines 33-36) as shown in Figure 3. In yet another embodiment, a plurality of concentric rings of upper and lower electrodes 102, 104 create a convoluted gas flow path as shown in Figure 5. Such configurations that control

and alter the flow of effluent into a spiral or circular flow path, outward and inward flow paths or flow paths like that shown in Figure 5 cannot be considered to teach a flow surface that is substantially absent projections or recesses that alter the effluent flow path" as recited in claim 1.

The Examiner's remarks in Paper No. 8 do not accurately reflect the teachings of Chiu. The Examiner contends on page 7 of the office action, that "Figures 1-6 also support flow surfaces absent of [sic] projections and or [sic] recesses." The position of the Examiner in this regard is not fully understood. Appellant has carefully studied Figures 1-6 and has been unable to find any unaltered flow path in the figures. Appellant contends, rather, that Figures 1-6 show exactly that which the specification of Chiu is drawn to and exactly that which Appellant's claim 1 distinguishes over.

Furthermore, Mundt teaches away from the invention of claim 1. For Mundt to be modified to remove its projections or recesses that alter the effluent flow path, the tube 80, the baffle 60, the fibrous mesh reactive element 74, and the fibrous mesh condensation element 76 would have to be removed. As discussed in column 8 of Mundt, the reactive element and the condensation element must interact with the effluent to reduce the undesired material from the effluent. Thus, the removal of these parts would result in an inoperative or less efficient device and is therefore taught against by Mundt. It would not be obvious, therefore, to one of ordinary skill in the art to modify Mundt to arrive at the invention claimed in claim 1.

Since neither Mundt nor Chiu disclose or suggest all that is recited in claim 1 and since claims 3-5, 8, 9, and 32 include all of the limitations of claim 1,

these claims distinguish over the proposed combination of references and the 35 USC 103(a) rejection of claims 3-5, 8, 9 and 32 should be reversed.

Claim 11, as discussed above, distinguishes over Mundt in its recital of a gas analyzer. Mundt discloses a pressure transducer, not a gas analyzer. The Examiner contends (beginning on page 9 of Paper No. 8) that the measured pressure is relatable to the hazardous gas content and is therefore a gas analyzer as required by the claims. The Examiner then goes on to state that it would be obvious to move the pressure sensor. Appellant disagrees with the Examiner's characterization of the pressure sensor of Mundt. The fact that other information might be derivable from the pressure data monitored by Mundt does not make Mundt's pressure sensor anything but a pressure sensor. Mundt does not disclose any analysis routines or any circuitry that takes the pressure signal and makes any gas analysis determinations. Mundt uses the pressure signal to monitor and control **pressure** in the Mundt apparatus. To alter the signal of Mundt would destroy this feature of the invention. Furthermore, Mundt and the Examiner's modification are both silent on the limitation of "when the hazardous gas content of the effluent exceeds a safety level..." The Examiner may not construct Appellant's invention using hindsight reasoning. There must be some suggestion to make modifications, aside from the suggestions provided by Appellant's disclosure. Thus, the invention of claim 11 is not rendered obvious by Mundt.

Chiu does not make up for Mundt's deficiencies. Chiu discloses an analyzer, but merely in a test system configuration, see column 8, line 53 through column 9, line 36. Chiu, therefore, does not disclose a controller that performs an action when the hazardous gas content exceeds a safety level, as required by claim 11. This valuable feature of Appellant's invention allows for a safeguard against unwanted release of undesirable gases and against system malfunction.

Since Mundt and Chiu fail to disclose or suggest all that is recited in claim 11, it is respectfully requested that the rejection of claim 11, and of claims 12, 14, and 34 depending therefrom, based on Mundt and Chiu be reversed.

(iii) 35 USC 103(a) rejection of claim 6

Appellant requests reversal of the Examiner's rejection of claim 6 under 35 USC 103(a) as being unpatentable over Mundt in view of JP51-129868 to Itoga et al (Itoga et al). The Examiner concludes that Itoga et al's teaching of the introduction of a reagent gas mixture renders claim 6 unpatentable. Appellant disagrees.

Mundt and Itoga et al do not render claim 6 unpatentable. Claim 6 depends from claim 1 and further recites a reagent gas mixer adapted to mix reagent gas with the effluent to further reduce the hazardous gas content of the effluent. Mundt does not disclose or suggest all of the elements recited in claim 1, as discussed above. Itoga et al's teaching of the introduction of a reagent gas mixture does not render claims 1 or 6 unpatentable. Even if Itoga et al's reagent mixture were applied to Mundt's system, the modified system would **still** have projections that alter the effluent flow path. Itoga et al does not teach an exhaust tube having an internal flow surface that is substantially absent projections or recesses that alter the effluent flow path and a microwave energy applicator to couple microwaves to the effluent flowing through the exhaust tube to reduce the hazardous gas content of the effluent. Therefore, Itoga et al does not teach that which Mundt lacks. Furthermore, Mundt has numerous projections and/or recesses that alter the flow path and that are necessary to the operation of the device and therefore would not be obviously removable, as discussed above.

Since claims 1 and 6 distinguish over the combination of Mundt and Itoga et al, it is requested that the rejection of claim 6 be reversed.

(iv) 35 USC 103(a) rejection of claims 7 and 15

The Examiner's rejection of claims 7 and 15 under 35 USC 103(a) as being unpatentable over Mundt in view of U.S. Patent 5,426,000 to Labib et al (Labib et al) is improper. The rejection is respectfully requested to be reversed.

Claims 7 and 15 depend from claims 1 and 11, respectively. Since claims 1 and 11 distinguish over Mundt for the reasons given above, and since Labib et al does not teach an unaltered flow in an exhaust tube (claim 1) or a gas analyzer (claim 11), claims 7 and 15 distinguish over Mundt and Labib et al for the same reasons as their base claims.

In addition, claims 7 and 15, explicitly state that the exhaust tube comprises monocrystalline sapphire. Mundt does not disclose or suggest the use of monocrystalline sapphire. The Examiner relies on Labib et al to teach the use of monocrystalline sapphire and is of the position that it would have been obvious to use monocrystalline sapphire as the chamber material in Mundt. Appellant respectfully disagrees with this conclusion of obviousness on several levels. In the first place, Labib is non-analogous art. One of ordinary skill in the hazardous gas reduction art would never look to the gas turbine engine art to improve on a reaction chamber material. In the second place, Mundt fails to provide any suggestion that there is a need to replace the quartz chamber described therein. In the third place, Labib does not even **teach** the advantages of any use of monocrystalline sapphire. Labib's mere mention of sapphire in column 1 is a discussion of the prior art relative to gas turbine engines. Labib's invention has

little to do with monocrystalline sapphire and one of ordinary skill in the art would not be moved, after reading Labib's description, to modify Mundt by replacing the chamber material. The Examiner states on page 8 that "Labib et al demonstrate the common industrial application of sapphire." Appellant is unable to find this demonstration within Labib et al. Furthermore, it is unclear which industry the Examiner believes monocrystalline sapphire to be commonly applicable in.

Since Labib et al does not make up for the deficiencies of Mundt with regard to the rejection of the base claims, and since Labib et al does not properly teach the invention of claims 7 and 15, it is respectfully requested that the rejection of claims 7 and 15 under 35 USC 103(a) be reversed.

(v) 35 USC 103(a) rejection of claims 10, 24, 26-29, and 35

Appellant requests reversal of the Examiner's improper rejection of claims 10, 24, 26-29, and 35 under 35 USC 103(a) as being unpatentable over Mundt. [Note that finally rejected claim 16, which is present claim 11, was also rejected under this ground.]

Mundt does not render claim 10 unpatentable. Claim 10 is to a gas treatment apparatus for reducing a hazardous gas content of an effluent from a process chamber comprising, inter alia, a gas analyzer capable of monitoring the hazardous gas content of the effluent and providing an output signal in relation to the hazardous gas content of the effluent, and a computer controller system capable of monitoring the output signal from the gas analyzer, and when the hazardous gas content of the effluent exceeds a safety level, performing an operation. Mundt discloses a pressure transducer, not a gas analyzer, as discussed above. The Examiner contends that the measured pressure is relatable to the

hazardous gas content. The Examiner then goes on to state that it would be obvious to move the pressure sensor. Appellant disagrees with the Examiner's characterization of the pressure sensor of Mundt. As discussed above, the fact that other information might be derivable from the pressure data monitored by Mundt does not make Mundt's pressure sensor anything but a pressure sensor. Mundt does not disclose any analysis routines or any circuitry that takes the pressure signal and makes any gas analysis determinations. Mundt uses the pressure signal to monitor and control **pressure** in the Mundt apparatus. To alter the signal of Mundt would destroy this feature of the invention. Furthermore, Mundt and the Examiner's modification are both silent on the limitation of "when the hazardous gas content of the effluent exceeds a safety level..." The Examiner may not construct Appellant's invention using hindsight reasoning. There must be some suggestion to make modifications, aside from the suggestions provided by Appellant's disclosure. Claims 11, 26, and 27 are allowable over Mundt for the same reasons as claim 10.

Claim 24 is directed to a process chamber for processing a substrate in a process gas and reducing emissions of hazardous gas to the environment comprising, inter alia, an exhaust tube comprising monocrystalline sapphire through which effluent from the process chamber may be flowed. Mundt fails to disclose or suggest an exhaust tube comprising monocrystalline sapphire. The Examiner has not applied a reference against claim 24 teaching the use of monocrystalline sapphire. Additionally, the cited references fail to teach the use of monocrystalline sapphire in a manner that would render claim 24 unpatentable. Reversal of the rejection of claim 24, and claim 35 depending therefrom, is requested.

Claim 28 is directed to a computer program product for operating a gas treatment apparatus and process chamber, to reduce the hazardous gas

content of an effluent formed during processing of a substrate in the process chamber comprising, inter alia, a gas analyzer program code for receiving the output signal relating to the hazardous gas content of the effluent from the gas analyzer, and safety operational program code that upon receiving an output signal that the hazardous gas content of the energized effluent exceeds a safety level, performs at least one of (1) adjusting process conditions in the process chamber to reduce the hazardous gas emissions, (2) operating an alarm to indicate a dangerous level of toxic or hazardous gas in the effluent, (3) providing a metering display that shows the level of emissions of hazardous gas, or (4) shutting down the process chamber. Mundt fails to analyze the hazardous gas content and fails to disclose a safety level, as discussed above. Therefore, Mundt does not disclose or suggest the invention of claim 28, or claim 29 depending therefrom.

(vi) 35 USC 103(a) rejection of claims 25 and 36

The rejection of claims 25 and 36 under 35 USC 103(a) as being unpatentable over Mundt as applied to claims 10, 24, 26-29, and 35 and further in view Chiu is improper. Accordingly, Appellant requests reversal of the rejections.

Claim 25 depends from claim 24. As discussed above, claim 24 is directed to a process chamber for processing a substrate in a process gas and reducing emissions of hazardous gas to the environment comprising, inter alia, an exhaust tube comprising monocrystalline sapphire through which effluent from the process chamber may be flowed. Mundt fails to disclose or suggest an exhaust tube comprising monocrystalline sapphire. Chiu, likewise fails to disclose or suggest the use of monocrystalline sapphire. Since neither reference discloses that

which is claimed, claim 25 is allowable over Mundt and Chiu for the same reasons as claim 24.

Claim 36 depends from claim 28. As discussed above, claim 28 is directed to a computer program product for operating a gas treatment apparatus and process chamber, to reduce the hazardous gas content of an effluent formed during processing of a substrate in the process chamber comprising, inter alia, a gas analyzer program code for receiving the output signal relating to the hazardous gas content of the effluent from the gas analyzer, and safety operational program code that upon receiving an output signal that the hazardous gas content of the energized effluent exceeds a safety level, performs at least one of (1) adjusting process conditions in the process chamber to reduce the hazardous gas emissions, (2) operating an alarm to indicate a dangerous level of toxic or hazardous gas in the effluent, (3) providing a metering display that shows the level of emissions of hazardous gas, or (4) shutting down the process chamber. Mundt and Chiu do not disclose or suggest that which is recited in claim 28. Therefore, claims 28 and 36 are patentable over Mundt and Chiu.

Thus, the rejections of claims 25 and 36 are not proper. The claims being allowable, Appellant requests reversal of the rejections.

Grouping of claims

Claims 1-9, 31 and 32 are to a gas treatment apparatus comprising, inter alia, an exhaust tube through which effluent from the process chamber may be flowed and a microwave energy applicator to couple microwaves to the effluent flowing through the exhaust tube to reduce the hazardous gas content of the effluent. Claims 10-15, 26-30, 33, 34 and 36 recite the features of a gas analyzer

capable of monitoring the hazardous gas content of the effluent and a computer controller system responsive thereto. Thus, claims 10-15, 26-30, 33, 34 and 36 are separately patentable over claims 1-9, 31 and 32 in that the features as claimed are not taught by the prior art of record and represent significant advancements in the art. Claims 24, 25 and 35 recite the separately patentable feature of an exhaust tube comprising monocrystalline sapphire. Thus, claims 24, 25, and 35 are patentable over claims 1-9, 31 and 32 and over claims 10-15, 26-30, 33, 34 and 36 in that the features as claimed are not taught by the prior art of record and represent significant advancements in the art.

Conclusion

It is believed that all rejections made by the Examiner have been addressed and overcome by the above arguments. Therefore, all pending claims are allowable. A reversal is respectfully requested.

Should there be any questions, Appellant's representative may be reached at the number listed below.

Respectfully submitted,

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(9) Appendix of Pending Claims

1. A gas treatment apparatus for reducing a hazardous gas content of an effluent from a process chamber, the gas treatment apparatus comprising:

(a) an exhaust tube through which effluent from the process chamber may be flowed, the exhaust tube having an internal flow surface that is substantially absent projections or recesses that alter the effluent flow path; and

(b) a microwave energy applicator to couple microwaves to the effluent flowing through the exhaust tube to reduce the hazardous gas content of the effluent.

2. The gas treatment apparatus of claim 1 wherein the exhaust tube comprises a length that is sufficiently long to reduce the hazardous gas content of a continuous stream of effluent flowing through the exhaust tube without recirculating the effluent in the exhaust tube.

3. The gas treatment apparatus of claim 1 wherein the exhaust tube comprises a length that is sufficiently long to provide a residence time of the effluent flowing through the exhaust tube that is at least about 0.01 seconds.

4. The gas treatment apparatus of claim 1 wherein the internal flow surface is adapted to provide a laminar flow of effluent through the exhaust tube.

5. The gas treatment apparatus of claim 4 wherein the exhaust tube comprises a cylinder and wherein the internal flow surface is parallel to the direction of the flow of the effluent through the exhaust tube.

6. The gas treatment apparatus of claim 1 further comprising a reagent gas mixer capable of mixing reagent gas with the effluent to further reduce the hazardous gas content of the effluent.

7. The gas treatment apparatus of claim 1 wherein the exhaust tube comprises monocrystalline sapphire.

8. The gas treatment apparatus of claim 1 further comprising an RF energy applicator to couple RF energy to the effluent in the exhaust tube.

9. The gas treatment apparatus of claim 1 wherein the exhaust tube comprises a distributor plate at an inlet of the exhaust tube, the distributor plate having holes adapted to direct effluent preferentially along the internal flow surface of the exhaust tube.

10. A gas treatment apparatus for reducing a hazardous gas content of an effluent from a process chamber, the gas treatment apparatus comprising:

(a) an exhaust tube through which effluent from the process chamber may be flowed;

(b) a microwave energy applicator to couple microwaves to the effluent flowing through the exhaust tube to reduce the hazardous gas content of the effluent;

(c) a gas analyzer capable of monitoring the hazardous gas content of the effluent in the exhaust tube and providing an output signal in relation to the hazardous gas content of the effluent; and

(d) a computer controller system comprising a computer readable medium having computer readable program code embodied therein, the computer controller system capable of monitoring the output signal from the gas

analyzer, and when the hazardous gas content of the effluent exceeds a safety level, performing at least one of the following:

(i) adjusting a power applied to the microwave energy applicator to reduce the hazardous gas content in the effluent,

(ii) adjusting process conditions in the process chamber to reduce the hazardous gas content in the effluent,

(iii) activating an alarm or metering display,

(iv) adding a reagent gas to the effluent before or after the effluent is energized, to reduce the hazardous gas content in the effluent, or

(v) terminating the process being conducted in the process chamber.

11. A process chamber for processing a substrate and reducing emissions of hazardous gas to the environment, the process chamber comprising:

(a) a support capable of supporting the substrate in the process chamber;

(b) a gas distributor capable of introducing process gas into the process chamber;

(c) a gas activator capable of activating the process gas to process the substrate, thereby forming an effluent containing hazardous gas; and

(d) an exhaust tube through which a continuous stream of the effluent may be flowed;

(e) a microwave energy applicator to couple microwaves to the effluent in the exhaust tube to energize the effluent;

(f) a gas analyzer capable of monitoring the hazardous gas content of the effluent in the exhaust tube and providing an output signal in relation to the hazardous gas content of the effluent; and

(g) a computer controller system comprising a computer readable medium having computer readable program code embodied therein, the computer controller system capable of monitoring the output signal from the gas analyzer, and when the hazardous gas content of the effluent exceeds a safety level, performing at least one of the following:

(i) adjusting a power applied to the microwave energy applicator to reduce the hazardous gas content in the effluent,

(ii) adjusting process conditions in the process chamber to reduce the hazardous gas content in the effluent,

(iii) activating an alarm or metering display,

(iv) adding a reagent gas to the effluent before or after the effluent is energized, to reduce the hazardous gas content in the effluent, or

(v) terminating the process being conducted in the process chamber.

12. The process chamber of claim 11 wherein the exhaust tube comprises at least one of the following characteristics:

(1) a length that is sufficiently long to reduce the hazardous gas content of the continuous stream of effluent flowing through the exhaust tube without recirculating the effluent in the exhaust tube;

(2) a length that is sufficiently long to provide a residence time of effluent in the exhaust tube that is at least about 0.01 seconds; or

(3) a flow surface that provides a laminar flow of effluent through the exhaust tube, the flow surface being parallel to the direction of the flow of the effluent through the exhaust tube and substantially absent projections or recesses that alter the effluent flow path.

14. The process chamber of claim 11 further comprising an RF energy applicator to couple RF energy to the effluent in the exhaust tube.

15. The process chamber of claim 11 wherein the exhaust tube comprises monocrystalline sapphire.

24. A process chamber for processing a substrate in a process gas and reducing emissions of hazardous gas to the environment, the process chamber comprising:

(a) a support capable of supporting the substrate;

(b) a gas distributor capable of introducing process gas into the process chamber;

(c) a gas activator capable of activating the process gas to process the substrate thereby forming effluent containing hazardous gas; and

(d) an exhaust tube comprising monocrystalline sapphire through which effluent from the process chamber may be flowed; and

(e) a microwave energy applicator adapted to couple microwaves to the effluent flowing through the exhaust tube to reduce the hazardous gas content of the effluent.

25. The process chamber of claim 24 wherein the exhaust tube comprises at least one of the following characteristics:

(1) a length that is sufficiently long to reduce the hazardous gas content of a continuous stream of the effluent flowing through the exhaust tube without recirculating the effluent in the exhaust tube;

(2) a length that is sufficiently long to provide an effluent residence time in the exhaust tube that is at least about 0.01 seconds; or

(3) a flow surface that provides a laminar flow of effluent through the exhaust tube, the flow surface being parallel to the direction of the flow of the effluent through the exhaust tube and substantially absent projections or recesses that alter the effluent flow path.

26. A process chamber for processing a substrate in a process gas while reducing emissions of a hazardous gas to the environment, the process chamber comprising:

(a) a support capable of supporting the substrate, a gas distributor capable of introducing process gas into the process chamber, and a gas activator capable of activating the process gas to process the substrate, thereby forming an effluent containing hazardous gas;

(b) an exhaust tube capable of exhausting the effluent from the process chamber and a gas energizer adapted to energize the effluent in the exhaust tube to reduce a hazardous gas content of the effluent;

(c) a gas analyzer adapted to monitor the hazardous gas content of the effluent in the exhaust tube and to provide an output signal in relation to the hazardous gas content of the effluent; and

(d) a computer controller system comprising a computer readable medium having computer readable program code embodied therein, the computer controller system capable of monitoring the output signal from the gas analyzer, and when the hazardous gas content of the effluent exceeds a safety level, performing at least one of:

(i) adjusting a power applied to the gas energizer to reduce the hazardous gas content in the effluent,

(ii) adjusting process conditions in the process chamber to reduce the hazardous gas content in the effluent,

(iii) activating an alarm or metering display,

(iv) adding a reagent gas to the effluent before or after the effluent is energized, to reduce the hazardous gas content in the effluent, or

(v) terminating the process being conducted in the process chamber.

27. The process chamber of claim 26 wherein the computer readable program code on the computer readable medium comprises one or more of:

(1) gas analyzer program code for receiving the output signals relating to the hazardous gas content of the effluent from the gas analyzer, and storing or passing the output signals to other program codes,

(2) gas energizer program code for adjusting a power level of the microwave applicator in relation to the output signals,

(3) reagent gas program code for operating a reagent gas mixer that adds reagent gas to the effluent in relation to the output signals, and

(4) safety operational program code that upon receiving an output signal that the hazardous gas content of the energized effluent exceeds a safety level, performs at least one of (1) adjusting process conditions in the process chamber to reduce the hazardous gas emissions, (2) operating an alarm to indicate a dangerous level of toxic or hazardous gas in the effluent, (3) providing a metering display that shows the level of emissions of hazardous gas, or (4) shutting down the process chamber.

28. A computer program product for operating a gas treatment apparatus and process chamber, to reduce the hazardous gas content of an effluent formed during processing of a substrate in the process chamber,

the gas treatment apparatus comprising an exhaust tube capable of exhausting effluent from the process chamber, a gas energizer adapted to energize

the effluent in the exhaust tube to reduce the hazardous gas content of the effluent, and a gas analyzer adapted to monitor the hazardous gas content of the effluent in the exhaust tube and provide an output signal in relation to the hazardous gas content of the effluent,

the computer program product comprising a computer usable medium having computer readable program code embodied in the medium, the computer readable program code comprising:

(a) gas analyzer program code for receiving the output signal relating to the hazardous gas content of the effluent from the gas analyzer, and storing or passing the output signal to other program codes; and

(b) safety operational program code that upon receiving an output signal that the hazardous gas content of the energized effluent exceeds a safety level, performs at least one of (1) adjusting process conditions in the process chamber to reduce the hazardous gas emissions, (2) operating an alarm to indicate a dangerous level of toxic or hazardous gas in the effluent, (3) providing a metering display that shows the level of emissions of hazardous gas, or (4) shutting down the process chamber.

29. The computer program product of claim 28 wherein the computer readable program code comprises program code for adjusting a power level of the microwave energy applicator in relation to the output signal to reduce the hazardous gas emissions of the effluent.

30. The computer program product of claim 28 wherein the computer readable program code comprises reagent gas program code for adding reagent gas to the effluent in relation to the output signal to reduce the hazardous gas emissions of the effluent.

31. The gas treatment apparatus of claim 1 wherein the microwave energy applicator comprises a waveguide for coupling microwaves to the effluent in the exhaust tube.

32. The gas treatment apparatus of claim 8 wherein the RF energy applicator comprises facing electrodes or an inductor coil.

33. The process chamber of claim 11 wherein the microwave energy applicator comprises a waveguide for coupling microwaves to the effluent in the exhaust tube.

34. The process chamber of claim 14 wherein the RF energy applicator comprises facing electrodes or an inductor coil.

35. The process chamber of claim 24 wherein the microwave energy applicator comprises a waveguide for coupling microwaves to the effluent in the exhaust tube.

36. The process chamber of claim 28 wherein the RF energy applicator comprises facing electrodes or an inductor coil.